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On report of the respective committees, the following were ordered to be published :—

Additions to the Catalogue of STARS which have Changed their Colors ; or which have appeared with different Colors at different times.*

BY JACOB ENNIS.

Sirius.—On the re-appearance of this star during the months of November and December, 1863, I very carefully watched its color. Its decided change of appearance since the early part of the year greatly interested me. Instead of a full bright green, it was of a pale yellowish green. During those two months the atmosphere passed through the extremes of variability, but the pale yellowish green of Sirius remained constant. On the 29th of December I asked Dr. Wilcocks, the discoverer of its being purple three years ago, how Sirius appeared to him now? Without knowing my opinion, and without any hesitation, he answered, "It is not as green as it was when visible last winter." This coincidence of his views with my own confirms the idea that he was not mistaken three years ago, as he since supposed, when he regarded the color of Sirius to be violet. According to these evidences this great star has had five distinct colors: red during the ancient times; white in 1850, and subsequently; violet in 1861; full green in the autumn and winter of 1862—3; pale yellowish green in November and December of 1863.

Note of April 19th, 1864. The above observations were written early in January. For the last three or four weeks the green color of Sirius has again been tinged with blue; but this evening no blue is visible, and the yellow mingled with the green is conspicuous. In this I am confirmed by a member of the Academy whose powers of observation are remarkably good. The clearness of the atmosphere is perfect, but the moon is large and bright, and I have a suspicion that the yellow of Sirius, though in a different quarter of the heavens, may be due to the moon's reflected rays. The following portions of this paper, except that on No. 21, were written previous to the 10th of November, 1863, at which date they were presented.

Altair and Deneb, or Alpha Cygni.—The former of these stars was described by Humboldt in 1850 as yellow and the latter as white. They were numbered 18 and 19 in this Catalogue, and announced to be blue in June, 1863. I had watched them for several months nearly every clear night, and, on the 20th of August, I first noticed that they were green. On all good nights since then they have appeared to myself and to others, whose opinions I have solicited, to be conspicuously green; but on damp, slightly hazy nights, from the effects of the atmosphere, they appear blue. It is rather oppressive for me to make this announcement, for I have been obliged already, in a former communication, to say that two other large stars, Sirius and Vega, had changed from blue to green. Certainly this change does not arise from any peculiarities of vision, for I have in all cases carefully consulted the views of others and found them to accord with my own. I know not how to attribute the change to atmospheric causes, for I had observed them all, except Sirius, to be blue several months before, in all weathers.

Vega.—For the last four or five weeks, this star has not appeared to me as green as during last summer. Its rather bluish appearance may, perhaps, be attributed to greater haziness of the atmosphere.

Castor.—See No. 10 of this Catalogue. In addition to the colors already given, the two companions of this double star have been described as follows: Yellow and yellowish by Sestini; greenish yellow and green by Dembowski;

* See these Proceedings for 1863, pp. 26, 96, 159.

bright and pale white by Webb; yellow and warm yellow by Miss Maria Mitchell.

20. Arcturus.—This is one of the stars denominated red by the ancients. In modern times, according to reliable observations, it has changed its color. J. F. Julius Schmidt, formerly of Ulmutz, recently made Director of the Astronomical Observatory at Athens, and distinguished for his observations on variable stars, which he communicated to the *Ast. Nach.*, says, that for eleven years he had considered Arcturus to be one of the reddest of the stars, and, especially in 1841, he had ranked it in color with Mars. To his surprise in 1852 he saw it to be yellow, and entirely destitute of any reddish hue. It then appeared to him by the naked eye lighter than Capella. Capella two years before had been described by Humboldt as yellow, with scarcely a tinge of red; since then Capella has become blue. During the present year, 1863, I have dozens of times and in all weathers observed Arcturus to be decidedly orange, and of a clear, beautiful color. In this I have been confirmed by other observers. The colors of Arcturus may therefore be stated as having been red, yellow and orange.

References have already been made in this Catalogue to the changes of color in double and multiple stars. The numbers, such as 3 : 7½, immediately after the names of the following double stars, indicate the magnitudes of the companions. The authorities are given after the colors. Some of these I have taken from the original papers, and some I have not so verified, but presume them all to be correct.

21. 95 Herculis, 5 : 5.—Hitherto catalogued as a diversely colored pair of stars to an extreme degree: one being described as apple green and the other as cherry red, and also as an astonishing yellow green and an egregious red. In 1856—58 they were nearly colorless and without any diversity of tint, and in this latter manner they were described by Struve in 1832—3, and by Sestini in 1844—5. Hence a probability of their being colorless once in about twelve years.—C. Piazzi Smyth.*

In the November number, 1863, of the *Monthly Notices of the Royal Astronomical Society*, a suggestion is made, from very high authority, that because the changes in the two companions have in all these cases been simultaneous, they are liable to the suspicion of having been produced by instrumental causes. But this apparent simultaneousness of change may have been produced by a real change in only one of them. If the two stars were white and one of them were to change to an "egregious red," then by contrast in close proximity, from the well known principle of complementary colors, the other would necessarily appear green. The operation of this principle has been very conspicuous in this city during political demonstrations and celebrations, when bright red lights have been kept burning in the streets. The ordinary gas-lights all around them have appeared strongly green. It is submitted that this cause for the simultaneous change in both stars is more probable by far than that three different instruments, in the hands of three different men, in three different countries and at as many different periods, should all, from some unknown cause, fall into the same error; and this not when directed at the stars generally, but only when pointed to a particular one.

22. Mizar, Zeta Ursæ Majoris, 3 : 4.—Both greenish white. Struve.
White and pale green. Webb.

Both yellow, the 4 has the deeper hue. Mitchell, 1860, April 30.†

23. Xi Bootis, 3½ : 6½.—Orange and purple. Webb.‡

Pale yellow and Orange. Mitchell, 1862, July 6.

* See the Proceedings of the British Scientific Association for 1863.

† See *American Journal of Science* and Art. July, 1863, for Miss Mitchell's observations.

‡ For several valuable popular papers on the double stars, by the Rev. Mr. Webb, see the first four volumes of the *Intellectual Observer*, London.

24. 32 Eridani, 5 : 7.—Bright yellow and flushed blue. Webb.
Orange yellow and pale blue. Mitchell, 1861, Jan. 31.
Yellow and pale green, very decided. Mitchell, 1862, Dec. 28.
Yellow and green. Mitchell, 1863, Jan. 1.
25. Gamma Virginis, 4 : 4.—Silvery white and pale yellow. Webb.
Both yellow. Mitchell, 1860, Feb. 20.
26. 35 Piscium, 6 : 8.—White and purplish. Webb.
The 6 is light yellow. The 8 is peculiar ; there is a brown mingling
with its reddish light. Mitchell, 1860, Jan. 2.
27. 23 Orionis, 5 : 7.—Greenish white and white. Struve.
Creamy white and blue. Webb.
The 7 is of a darkish color. Mitchell, 1860, Mar. 6.
28. 39 Ophiuchi, $5\frac{1}{2}$: $7\frac{1}{2}$.—Pale orange and blue. 1838.
The $7\frac{1}{2}$ yellow. Sestini, 1846.
" bluish. Smyth, 1851.
" clear blue. Webb, 1854.
29. Polaris, Alpha Ursæ Minoris, $2\frac{1}{2}$: $9\frac{1}{2}$.—Yellow and dull white. Struve.
Yellow and blue. Sestini, Dawes, Webb.
30. Iota Cancræ, $5\frac{1}{2}$: 8.—The 8 deep garnet, Feb. 8, 1782 ; bluish Dec. 28,
1782 ; and blue, Mar. 12, 1785. Herschel, Sr.
Pale orange and clear blue. Webb.
31. Sigma Scorpii, 4 : $9\frac{1}{2}$.—The $9\frac{1}{2}$ white. Sestini.
Dusky and plum color. Webb.
32. Delta Corvi, 3 : $8\frac{1}{2}$.—The $8\frac{1}{2}$ white. Sestini.
Pale yellow and purple. Webb.
33. π Bootis, $3\frac{1}{2}$: 6.—Both white ; a ruddy tinge sometimes in 6. Webb.
34. Alpha Herculis, $3\frac{1}{2}$: $5\frac{1}{2}$.—"Intense cærulea." Struve.
Orange and emerald. Webb.
35. Delta Serpentis, 3 : 5.—Yellow tints. Dembowski.
Bright white and bluish white. Webb.
Both Bluish. Webb.
36. Eta Cassiopeæ, 4 : $7\frac{1}{2}$.—"Flava et purpurea." Struve, Fletcher.
Red and green. Herschel, Jr., South.
Yellow and orange. Sestini.
Dull white and lilac. Webb.
37. Iota Bootis, $4\frac{1}{2}$: 8.—The 8 azure. Sestini.
The 8 lilac. Webb, 1850.
Light yellow and dusky white. Webb, 1850.
38. 39 Bootis, $5\frac{1}{2}$: $6\frac{1}{2}$.—White and lilac. Some writers ascribe a bluish and
some a ruddy tint to $6\frac{1}{2}$. Webb.
39. Epsilon Lyræ.—The two companions of this double star are designated.
Epsilon 1 and Epsilon 2. Each of these again are double.
Epsilon 1, 5 : $6\frac{1}{2}$. Yellow and ruddy. Webb.
During five years the 5 was bluish. Struve, Dembowski.
40. Gamma Cygni, 4 : 7.—Both white. Herschel, Sr.
Viridi-cærulea. Struve.
The 7 light emerald. Smyth, 1839.
Golden yellow and flushed grey. Webb, 1850.
41. Beta Lyræ.—A quadruple star ; 3 : 8 : $8\frac{1}{2}$: 9.

1864.]

42. Gamma Lyræ, of 3d magnitude.—Both these stars, Beta Lyræ and Gamma Lyræ, seem to be changing their colors. Herschel, Sr., and South gave Beta as white. Next, Smyth, in 1834, gave the general impression as white, the four companions being in the following order: very white and splendid, pale grey, faint yellow, light blue. He gave Gamma Lyræ then as being bright yellow. Schmidt regarded the colors of both Beta and Gamma the same—yellowish white—from 1844 to 1855. Webb, in 1849—50, regarded Gamma as much less yellow than Beta, if not white. In 1862, the latter observer found Gamma the paler in tint, though the difference was not considerable. According to these statements Beta changed from white to yellow and Gamma from yellow to white. Both were of the same color,—yellowish white,—according to Schmidt, about 1844. The only discrepancy is Schmidt, for the latter portion of his time, the former portion being remarkably confirmative.
43. Eta Lyræ, 5 : 9.—Cærulea. Struve, during five years, about 1830.
 Sky blue and violet. Webb, 1834.
 The 5, yellow. " 1849—50.
 " pale yellow. " 1862.
44. Gamma Andromedæ, $3\frac{1}{2}$: $5\frac{1}{2}$.—Deep yellow and sea green. Webb, 1862.
 The $5\frac{1}{2}$ is double, and the colors of the two latter have been given as follows:
 Subviridis et violacea. Secchi, 1856.
 Yellow and blue. Sir W. K. Murray, 1857.
 " " Dawes, Jacob.
45. Gamma Arietis, $4\frac{1}{2}$: 5.—Both "egregie albæ." Struve, 1830.
 White. Dembowski, 1852, 1854, 1856.
 The same, either white or light yellow. Piazzi Smyth, 1856.
 Full white and faint blue. Webb, 1862.
46. Iota Trianguli, $5\frac{1}{2}$: 7.—White or yellow and blue. Secchi.
 Topaz yellow and green. Webb, 1862.
47. Gamma Ceti, 3 : 7.—The 7 tawny. Webb, 1850.
 Pale yellow and lucid blue. Webb, 1863.
48. Gamma Leonis, 2 : 4.—White and reddish white. Herschel, Sr.
 Bright orange and greenish yellow. Webb.
49. 72 P. II. Cassiopeæ, $4\frac{1}{2}$: 7 : 9.—White, blue, ruddy violet. Dembowski. 1854—6.
 Pale yellow, lilac, blue. Webb, 1863.
50. Kappa Cephei, $4\frac{1}{2}$: $8\frac{1}{2}$.—The $4\frac{1}{2}$ greenish. Struve.
 Pale yellow and blue. Webb, 1863.
51. Zeta Cephei, 5 : 7.—Yellowish and blue. Struve, 1831.
 Both bluish. Smyth, 1839.
 White and tawny or ruddy. Webb, 1850.
 Flushed white and pale lilac. " 1851.
52. 40 Draconis, $5\frac{1}{2}$: 6.—Both white. Struve, 1832.
 Both white. Webb, 1839.
 Both white or yellowish. Webb, 1850.
 Both yellow, the $5\frac{1}{2}$ deeper. " 1856 and 1863.
53. 12 Canum Venaticorum, $2\frac{1}{2}$: $6\frac{1}{2}$.—White and red. Herschel, Sr.
 "With all attention I could perceive no contrast of colors in the two stars." Herschel, Jr., 1830.

[March

- Both white. Struve, 1830.
 Yellow and blue. Sestini, 1844.
 Full white and very pale white. Smyth, 1850.
 White or a little yellowish, and tawny or lilac. Webb, 1850.
 Pale reddish white and lilac. Smyth, 1855.
 White and pale olive blue. Dembowski, 1356.
 Same as in 1850, but with very little contrast. Webb, 1862.
 Flushed white and pale lilac. Webb, 1862.
54. Sigma Coronæ, 6 : 6½.—Creamy white and smalt blue. Webb, 1862.
 The 6½ has had many changes, as follows ; certainly not blue and differing very little from the other. South, 1825.
 White. Struve, 1836.
 A yellow ashy and doubtful blue. Dembowski, 1854—57.
 Sometimes blue, sometimes yellow. Secchi, 1855—57.
 "At one time ruddy, at another time bluish, apparently changing white being looked at ; a versatility of hue which I have remarked in other stars similarly circumstanced." Webb, 1850—5.
55. Mu Cygni, 5 : 6.—White and pale blue. Struve, 1831.
 Yellow and more yellow. Sestini, 1844.
 Reddish yellow and olive. Dembowski, 1853—4.
 Clear light yellow and ashy yellow. Dembowski, 1855.
 "The 5 yellow, while the 6 showed the curious effect of an undecided and changeable hue—blue and tawny." Webb, 1850—1.
 The 5 yellow. Webb, 1862.
 "Secchi's colors are here uncertain and variable."
56. Alpha Piscium, 5 : 6.—Greenish and pale blue. "There seems to be something peculiar in the color of the smaller star, as to which observers are strongly at variance with each other, and even with themselves. Some see no contrast, some agree with Smyth, some find it tawny and ruddy. The details are curious but too long for insertion here. Other small stars show a similar uncertainty." Webb.

The frequent changes in some of these stars,—the last three or four of this Catalogue especially,—are remarkable, and seem inexplicable to astronomers. I presume the difficulty arises, not as is supposed from the atmosphere, or from the instruments, or from personal peculiarities, but chiefly from the frequency of the real changes in the stars. If, for instance, it be complained that "Secchi's colors are uncertain and variable," it is because in such instances the colors of the stars are uncertain and variable.

An addition has been made to the title of this Catalogue to obviate the objection that possibly some of the apparent changes of color of the stars may be merely the errors of observation, or the effects of the atmosphere, and not real changes in the celestial bodies. Nevertheless, an apparent change is a fact in the constitution of the world, and deserves a notice and an explanation. From whatever causes these changes may arise, there is needed a faithful collection of all the facts in this department of astronomy. They are scattered about in many volumes and many various scientific depositories, and no one, as far as I am aware, has brought them together or made them a special study. But in making such a collection, or catalogue, no changes should be omitted. Whether we regard them as apparent or real, whether they be small or great, whether they may have been slow or sudden, none should be suppressed by the compiler in his catalogue. To admit some and reject others because in his opinion some are right and others are wrong, would be making his work a confused medley of facts and opinions unworthy of reliance. If, as appears undeniable, there be changes in the colors of the stars, then, from the nature of things, there may be small changes as well as great ones. To reject a re-
 1864.]

corded change simply because it is small, would therefore be a real misrepresentation of the case, and a virtual falsification of the records. Moreover, the colors as they stand recorded are from experienced observers,—men whose lives have been devoted to an accurate representation of facts, who do nothing without care and deliberation, and whose common and avowed practice is not to record any color when the atmosphere is not favorable for such observations.

As already stated, there are difficulties in deciding on colors by the naked eye when the star is not large, and when the departure from white is small. But this difficulty is not in the way of large stars, as Arcturus and Sirius; nor does it apply to the telescope, except in the very smallest magnitudes. To decide between two different colors, such as red and blue, is never difficult; and when two colors are blended, it is the custom to name them both, as bluish green, reddish yellow, and the like. The disturbing effects of the atmosphere, or of the instrument, may be detected either immediately or after several nights of observation. The atmosphere cannot color one star and leave all the other stars in the same neighborhood uncolored. The telescope cannot act peculiarly on any one star; it must treat all alike, especially of the same magnitude and color. Simple comparison is therefore an admirable test; and another important test is time—watchfulness every night through different changes of weather. If hereafter even this shall not be found satisfactory in any one locality, then simultaneous observations at widely distant places will most certainly eliminate all suspicion of mistake. For instance, observations may be made at Australia, the Cape of Good Hope, and Chili in the southern hemisphere; and in the northern hemisphere both on the Pacific and Atlantic coasts of America, on the Atlantic coast of Europe, in Russia, and in Hindoostan. If the star shall prove of the same color at all these different regions at the same time in favorable weather, then that color may be regarded as unquestionable. Even by using one locality alone absolute certainty may be acquired,—as the red colors of Aldebaran, Betelgeuze, and Antares. The same certainty may be looked for in this as in other departments of astronomy, and even greater certainty than in many. There is an uncertainty, in opinions of wise men, of three millions of miles in the distance of the earth from the sun; and yet this uncertain distance is used as a measuring line to fathom other and far greater distances. But this uncertainty to so large a degree does not take away from the supreme value of the determinations nevertheless. These determinations, with all their known reservations, are held as of the highest importance. So in the colors of the stars; mistakes may be made, the intermixtures of error may certainly exist, though we cannot tell exactly where they are, and yet the present recorded observations are precious beyond estimation. And a time is coming when simultaneous observations from various positions in both hemispheres will render them beyond suspicion. To hasten on this time we have only to make good use of the materials already on hand.

Why the changes in the colors of the stars are not more frequently observed, was pointed out in a former communication. Why the belief in their real occurrence is hard to be admitted, and why their observed changes are ascribed to supposable errors from the instruments, from the atmosphere, and from personal deficiencies, seems to arise from the opinion that such vast bodies cannot possibly undergo great changes in a short time. But this opinion rests on no known scientific grounds. When fairly viewed, the fixedness of the colors of the stars should not seem more likely than the fixedness of their positions. Indeed the two ideas are very much alike. In ancient phrase, the stars were said to be "rivetted" to the vault of heaven. Now we know from observations more refined than many of them move, and we have a conviction, from the nature of attraction, that they must all move. In like manner, in a universe where every known object is subject to change in various ways, our first ideas should be that the colors of all the stars must change. Hence we should approach the recorded changes with favorable judgments. If we are to have any

[March

prepossessions in the case, they should be that the changes are real in the stars themselves. And when we reflect on the habitual caution of long experienced observers, men whose very existence is devoted to the accurate delineation of fact, we should place a high reliance on their recorded observations, and not think that they have lightly allowed themselves to be imposed upon by optical illusions.

I cannot hope to be able to add anything to the knowledge of practised observers respecting the sources of error and the rules to be observed in making observations; but as these have never, that I am aware, been embodied in print, I offer the following, chiefly for the assistance of the many who may be disposed so observe the larger stars with the naked eyes. Such stars are indeed very few, but the observations may be the more useful from being made frequently and by many persons.

1. Damp and slightly hazy atmospheres make a green star appear blue. This may be from the same principle that the deep ocean, the clear sky, and the distant mountains appear blue. Damp nights that are perfectly clear do not have this effect.

2. Moonlight greatly obscures the colors of the stars, giving them a yellowish hue.

3. Before the daybreak makes its appearance in the east, the rays of the sun refracted through the higher regions of the atmosphere, may cause a general whiteness of the stars.

4. Artificial lights reaching the eye obscure the colors of the stars.

5. On account of the faintness of the light of the stars, the eye often requires to be fixed upon them for a considerable time before their impressions take full effect.

6. Comparisons between neighboring stars, and some practice in star observations, are often necessary to decide on the real colors of the stars.

7. The atmosphere must have like effects upon similar stars in the same neighborhood. Hence a peculiarity observed in any star may be brought to a determination.

8. Observations on the same star during a considerable interval of time and through different changes of weather, may aid in giving confidence to a determination.

9. Perfect independence and candor are necessary. Our previous judgments are apt to warp these delicate impressions on the retina, and whether we have derived these judgments from ourselves or others, we must be careful to lay them completely aside. For want of doing this we may not notice a change of color, although such a change may have been before our vision.

10. Personal peculiarities of vision may be ascertained by consultation with others.

11. Discrepancies between the accounts of two observers may arise from differences of dates; hence, in apprehension of sudden and frequent changes in the stars, the dates of observations should be carefully given.

Description of a new Labroid Genus allied to *TROCHOCOPUS* Gthr.

BY THEODORE GILL.

Dr. Ayres has indicated, under the name *Labrus pulcher*, a Californian representative of the family of Labroids. That species was subsequently referred by Dr. Günther to his genus *Semicossyphus*, in which it was retained by myself with the proviso that "its generic position remains to be confirmed, although there is little doubt that it really is a *Semicossyphus*." Having since received, through the kindness of Dr. Cooper, a specimen of the species, I find that it has not the "lateral teeth distinct," as in *Semicossyphus*, but an "obtuse osseous ridge round the edge of the jaws, without distinct lateral teeth," as in *Trochocopus* Gthr., to which Günther should have referred it. I am not acquainted with his reasons for considering the species closely 1864.]